

NOAA SECTORAL APPLICATIONS RESEARCH PROGRAM (SARP)

PROJECT ANNUAL REPORT

PROJECT TITLE

Estimating the impacts of complex climatic events: the economic costs of drought in Colorado, Nebraska and New Mexico

INVESTIGATORS

(Research team and full contact information)

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Project years 3

Time Period addressed by Report (*e.g., August 2002-March 2003*)

April 2007 – March 2008

I. Preliminary Materials

This study focuses on the economic losses associated with drought. Drought occurs every year across different regions of the United States. The amount usually quoted for annual average economic losses in the United States due to drought is \$6-8 billion (FEMA 1995). This number likely underestimates the actual impact of drought and certainly is not representative of the last ten years. Economic estimates of the impacts of past droughts have been difficult to produce and are likely to be either significantly higher or lower for any given year than the FEMA estimate. Drought is also possibly the only natural hazard in which the secondary impacts may be greater than the primary impacts because of the way they filter through the economy. Few or no official loss estimates exist for the energy, recreation/tourism, forestry, and environmental sectors. As the momentum for implementing mitigation strategies to reduce future drought impacts increases, it is evident that the United States needs a concerted effort to quantify the economic impacts of drought in order to understand the monetary benefits of these proactive risk mitigation strategies.

This study proposes to assess the economic impacts of past and present drought on the economies of Colorado, Nebraska, and New Mexico. The researchers have developed extensive links within these states in operational and policy settings, and these states have experienced a variety of drought conditions since 1995. The end goal is to provide a prototype methodology for assimilating, evaluating, and analyzing economic impacts data in support of the NIDIS. The study will be developed as follows: (1) Determine the geographical level of the analysis (Colorado, New Mexico, Nebraska, and Wyoming) and the level of detail; (2) identify and characterize significant droughts over the past ten years; (3) carry out interviews and surveys with key state agency and industry personnel on specific direct impacts of past droughts and impacts-reporting criteria for water tourism, agriculture, and wildfires; (4) identify and measure directly imposed economic damages; and (5) identify and measure indirect damages in sectors linked to agriculture, energy and tourism.

A Project Abstract (*Limit to one page*)

The study will be developed as follows: (1) Determine the geographical level of the analysis (Colorado, New Mexico, Nebraska, and Wyoming) and the level of detail (e.g., local business and tax impacts versus broad categories like agriculture, manufacturing, recreation, etc.), which affects the way one interprets the input-output coefficients of the localized IMPLAN model (there may be no substitutes for an agricultural input creating large multiplier effects locally, but statewide there may be plenty of alternative sources of supply, so statewide multiplier effects in some cases may prove to be less important). (2) Identify and characterize significant droughts over the past ten years (*Hayes, Pulwarty*). (3) Carry out interviews and surveys with key state agency and industry personnel on specific direct impacts of past droughts and impacts-reporting criteria for water tourism, agriculture, and wildfires (*Pulwarty, Hayes, Howe*). (4) Identify and measure directly imposed economic damages (e.g., direct losses of value added in agriculture and damage to agricultural capital assets including tree crops). This will also include looking at issues such as how payments from federal crop insurance reduce damages as seen from a state viewpoint but not from a national viewpoint (*Supalla, Howe, Ding*). (5) Identify and measure indirect damages in sectors linked to agriculture, energy and tourism. Lost value-added income in sectors linked to agriculture, for example, can be counted for short-run impacts (*Team*).

B Objective of Research Project (*Limit to one paragraph*)

The investigators will begin by examining recent droughts and the sectors affected in Nebraska, Colorado, and New Mexico, with an emphasis on the 2002 drought. This was one of the driest years for each of the three states over the past 100 years. This drought was embedded in the longer-term dry period that extended from 1999-2004. From this, a list of sectors particularly vulnerable to droughts will be developed for each state. Information about the economic impacts will be based from available data, as well as information obtained from telephone surveys and semi-structured interviews to be conducted with state-level department personnel in the Tourism, Agriculture, Natural Resources and Water sectors. In some cases, information will also be collected and assimilated from state-level representatives of some of the federal agencies as well, particularly within USDA. The project will begin to understand direct and indirect losses and work to identify and understand various economic loss estimation techniques available, with the hope of encouraging a standardization of estimates so that official can begin to compare “apples to apples”, and be able to make decisions based on these estimates. Finally, the investigators would like to identify and/or develop methodologies that could be used by officials in order to estimate drought losses in various locations, sectors, and geographic scales around the country.

The investigators anticipate a variety of results and benefits for both the public and the scientific community as a result of this project. First, this study will provide the opportunity to begin to answer some very specific questions related to drought impacts on individual sectors that have rarely been addressed such as the energy, timber, and recreation and tourism industries, and others. Second, this

project will encourage the development of standardized methodologies for estimating economic losses from droughts at national, regional, state, and local scales. It will also assist in developing standard methods for identifying, collecting, and quantifying drought impacts at these scales as well. Third, this project will be a step toward the development of national and regional assessments of drought conditions across the United States. Finally, this project supports both the National Integrated Drought Information System (NIDIS) and the proposed National Drought Preparedness Act (2005). Both of these national initiatives call for better drought impact assessment methodologies in order to improve drought mitigation and response actions in the United States. Mitigation and preparedness are the keys to reducing future drought impacts. But to provide officials with the information necessary to make decisions regarding drought mitigation, economic loss estimates need to be available. The Council of Governors' Policy Advisors noted that state officials are reluctant to dedicate money and resources to mitigation of any natural hazard unless these "hard" numbers are known (Brenner 1997). These state officials had a general understanding that "mitigation makes sense," but their desire was for quantitative proof. In fact, this report identified the "lack of information" as the major obstacle to adopting mitigation strategies. Similarly, the NSTC's (2005) "Grand Challenges for Disaster Reduction" document identified quantifying "the monetary benefits of disaster mitigation using economic modeling" as a challenge for developing hazard mitigation strategies and technologies. This project is a beginning step to overcome the "lack of information" obstacle and provide drought-related economic loss estimates and estimation techniques.

C Approach (including methodological framework, models used, theory developed and tested, project monitoring and evaluation criteria) include a description of the key beneficiaries of the anticipated findings of this project (e.g., decision makers in a particular sector/level of government, researchers, private sector, science and resource management agencies) (*Limit to one page*)

D Description of any matching funds/activities used in this project (*Limit to one paragraph*)
 The National Drought Mitigation Center also has complementary funding through a grant provided by the USDA's Risk Management Agency (RMA). This RMA funding supports Ya Ding's salary, as well as a subcontract to the University of New Mexico that supports Janie Chermak there.

II. ACCOMPLISHMENTS

A. Brief discussion of project timeline and tasks accomplished. Include a discussion of data collected, models developed or augmented, fieldwork undertaken, or analysis and/or evaluation undertaken, workshops held, training or other capacity building activities implemented. (*This can be submitted in bullet form – limit to two pages*)

Accomplishments during the second, third, and fourth quarters of 2007 (April-December):

- Mike Hayes made presentations on the economic impacts of drought at the Workshop on Societal Impacts of Decadal Climate Variability in the United States held in Kona, Hawaii, April 26-28, and at the Climate Change Research Needs Workshop sponsored by the Western States Water Council in Irvine, CA, May 16-18.
- On June 18, a teleconference of the entire project team was held to discuss various issues regarding to the project. The UNL participants met again on June 26 to follow up on some of the issues and questions raised up during the teleconference.
- Ya Ding and Karina Schoengold with UNL's School of Natural Resources attended the American Agricultural Economics Association annual meeting in Portland, OR, July 29-31, and presented

the paper “The Impact of Weather Extremes on Agricultural Production Methods: Does Drought Increase the Adoption of Conservation Tillage Practices?”

- In August, Ya Ding, Karina Schoengold and Tsegaye Tadesse met and discussed the availability and application of alternative drought indices in economic modeling.
- Ya Ding and Karina Schoengold attended the Heartland Environmental and Resource Workshop held in Ames, IA, September 16-17. At this workshop, they presented results from the research project “The Impact of Weather Extremes on Agricultural Production Methods.”
- Ya Ding produced two documents highlighting the economies of Colorado and Nebraska, the recent economic impacts resulting from droughts in those two states, and the drought vulnerable sectors in each state. Ya has also been working with Janie Chermak at the University of New Mexico to develop a similar document for New Mexico.
- Ya Ding and Michael Hayes prepared a white paper entitled “Measuring economic impacts of drought: a review and discussion”. This paper has been distributed to NDMC faculty and staff to collect comments.
- In December, Ya Ding, Kelly Smith, and Brian Fuchs submitted a drought review article “Economic Impacts of the 2007 Drought” to *Crop Insurance Today*. This article is also available in the Winter 2008 edition of the NDMC’s quarterly newsletter, *DroughtScape*, [<http://drought.unl.edu/droughtscape/2008Winter/dswinter08-agurban.htm>].

Accomplishments during the first quarter of 2008 (January-March):

- A collection of impacts from 2007 from around the United States has been assembled and will be included as part of a presentation at the American Meteorological Society’s annual meeting in New Orleans, LA, January 20-24, 2008. These impacts include both quantitative economic impacts and qualitative impacts within the following categories: agriculture, water, energy, environment, fire, and social.
- A dialogue on the economic impacts of drought continued during the quarter with a small group of scientists at the National Climatic Data Center (NCDC) in Asheville, NC. NCDC publishes the most “official” economic impacts of natural hazards, and is very interested in the economic impact assessment methodologies-aspect of this project [<http://www.ncdc.noaa.gov/oa/reports/billionz.html>].
- Ya Ding continues to work on the investigation of conservative farming practices and the impact climate has on these practices by agricultural producers.
- Ya Ding's abstract entitled "Climate Risks and the Adoption of Conservation Tillage Systems: An Application of Growth Mixture Model" has been accepted for presentation at the Western Agricultural Economics Association annual meeting at Big Sky, Montana, June 25-27.
- Work being led by Dr. Janie Chermak at the University of New Mexico has identified the drought vulnerable sectors for New Mexico, and has identified the critical climate factors related to pecan production in the state.
- On January 22, Mike Hayes presented a review of drought impacts, including the known economic impacts, across the United States during 2007 at the American Meteorological Society’s Annual Meeting in New Orleans, LA.
- The NDMC also presented a poster on the impacts of a future drought on ethanol production in the United States at the American Meteorological Society’s Annual Meeting in New Orleans, LA, January 21-24.
- In March, Ya Ding and Mike Hayes worked with North Carolina officials to identify economic impact estimation strategies for North Carolina.
- Also in March, Ya Ding and Mike Hayes began discussion with officials in Hawaii to identify economic impact estimation strategies that could apply for Hawaii.

B. Summary of findings, including their potential or actual implications for efforts to develop applications, methods, and science-based decision support capacity/systems and to foster sustainable resource management and vulnerability reduction. (Limit to two pages)

During the past year, the investigators have focused their attentions on the identification of the drought vulnerable sectors of New Mexico, Colorado, and Nebraska. As a result, documents describing these sectors have been developed. For Nebraska, the most vulnerable sectors were determined to be agriculture (both crop and livestock production), energy (both hydropower electricity generation and thermoelectricity), and recreation and tourism. For Colorado, the most vulnerable sectors include agriculture, municipal water use, recreation and tourism, and hydropower electricity generation. In New Mexico, the most vulnerable sectors were identified as being agriculture, recreation and tourism (fishing, hunting, boating, skiing), and real estate. For example, New Mexico leads the nation in pecan industry. Research looking at estimating the economic impact of drought on this industry has shown that there is a statistical link between precipitation in northern New Mexico, levels in Elephant Butte Reservoir, and the pecan production in southern New Mexico. More investigations are planned to reconfirm this conclusion.

Droughts hit both the southeastern and the southwestern United States hard during 2007. Investigators collected and archived economic impacts during the year using the NDMC's Drought Impact Reporter tool [<http://droughtreporter.unl.edu/>]. Impacts were reported in the following sectors: grain production, citrus production, livestock production, nursery crops and landscape services, recreation and tourism, public utilities, and residential water use.

Graduate Student, Prabhakar Shrestha, should complete his Masters thesis during Summer 2008, which is focusing on the economic impacts of drought on the rafting industry along the Arkansas River in Colorado. As part of his research, Mr. Shrestha conducted personal interviews during the year with seven outfitters along the Arkansas River. He also collected a variety of river use data from the Arkansas Headwaters Recreation Area and Colorado officials, as well as climate and streamflow data from the USGS. The initial results of his research have found that the relationship between flow and customer demand is not linear, but are affected by both temperature and precipitation conditions.

Mr. Shrestha's findings show that although lower customer numbers can be predicted for the severe drought year of 2002, the numbers are actually lower than what streamflows would have estimated. This result highlights that additional external factors, besides drought alone, play a significant factor in the economic impacts that affect a specific sector like rafting (within the larger recreation and tourism sector). Understanding the roles of these external factors is a key component in being able to estimate the economic impacts of drought.

Finally, given the combined role of the NDMC's Drought Impact Reporter and this project on estimating the economic impacts of drought, officials from Hawaii have become very interested in developing a similar methodology to better understand economic losses in that state as well. Interactions, discussions, and information sharing will be taking place over the next few months as a result of this interest.

C. List of any reports, papers, publications or presentations arising from this project; please send any reprints of journal articles as they appear in the literature. Indicate whether a paper is formally reviewed and published. (No text limit)

1. Ya Ding has developed a white paper titled "Measuring Economic Impacts of Drought: A Review and Discussion."

2. Ya Ding developed a document titled "Drought Vulnerable Sectors in Nebraska."

3. Ya Ding developed a document titled “Drought Vulnerable Sectors in Colorado.”
4. Janie Chermak and Jee Hwang developed a document on the “Drought Vulnerable Sectors in New Mexico.”
5. Janie Chermak and Jee Hwang have developed a draft document on the impacts of drought on the Pecan Industry in New Mexico.
6. Prabhakar Shrestha and Karina Schoengold wrote an article titled “Potential Economic Impact of Drought on Rafting Community” for the University of Nebraska-Lincoln Extension publication “*Cornhusker Economics*”.
7. Ya Ding, Kelly Smith, and Brian Fuchs submitted a drought review article “Economic Impacts of the 2007 Drought” to *Crop Insurance Today*. This article is also available in the Winter 2008 edition of the NDMC’s quarterly newsletter, *DroughtScape*,
[<http://drought.unl.edu/droughtscape/2008Winter/dswinter08-agurban.htm>].

D. Discussion of any significant deviations from proposed workplan (e.g., shift in priorities following consultation with program manager, delayed fieldwork due to late arrival of funds, obstacles encountered during the course of the project that have impacted outcome delivery). (Limit to one paragraph)

E. Where appropriate, describe the climate information products and forecasts considered in your project (both NOAA and non-NOAA); identify any specific feedback on the NOAA products that might be helpful for improvement. (bulleted response)

The weekly U.S. Drought Monitor product has been valuable in assessments of drought conditions across Nebraska, Colorado, and New Mexico. This product is jointly produced by NOAA Climate Prediction Center and National Climatic Data Center, USDA, and the National Drought Mitigation Center.

III. Graphics: Please include the following graphics as attachments to your report

- A. One Power point slide depicting the overall project framework/approach/results to date
- B. If appropriate, additional graphic(s) or presentation(s) depicting any key research results thus far
- C. Photographs (if easy to obtain) from fieldwork to depict study information (if applicable).

IV. WEBSITE ADDRESS FOR FURTHER INFORMATION (IF APPLICABLE)

V. ADDITIONAL RELEVANT INFORMATION NOT COVERED UNDER THE ABOVE CATEGORIES.